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N. Slavov

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MEASUREMENT OF MOISTURE IN TYPICAL CHERNOZEM SOIL WITH AN AM-11 RESISTANCE SOIL MOISTURE METER

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Laboratory and field tests of the AM-11 instrument in order to ascertain its suitability for operation in typical chernozem soil were made at the Corn Institute in Knezha during the period from 1963 to 1965.

The AM-11 resistance moisture meter, designed by A. I. Danilin, consists of an M-1101 type megohmmeter and a set of transducers for soil moisture measurement to a depth of 100 centimeters. The designer of the instrument believes it more accurate than the gravimetric method (2). Other authors think that the method can be used for shorter-term periodic observations, the accuracy of the measurement being deemed acceptable (4). In our country the instrument has been tested only by A. Vangelov in chernozem-smolnitz soil and it is thought that it can be used in practice in this soil-type region if higher soil moisture content is maintained (1).

The instrument was tested under field conditions at depths of 20, 40, 60, 80, 100, 120, 140 and 160 centimeters with 10 repetitions. The laboratory tests were compared with the gravimetric method.

The soil type in which the test was made was typical chernozem soil, shallowly micellar, developed on loess. It had a heavy sandy-clayey mechanical composition. No significant differences in soil volume were established whether the soil was moist or arid. Maximum field moisture content for all horizons of the soil type averaged 25.8 percent, maximum hygroscopic moisture content 9.6 percent, and wilting moisture about 13.6 percent.

Laboratory calibration of the instrument was effected by placing soil samples in glass tanks and more than 30 observations were made whereby the 80 transducers of the instrument were tested. The resultant calibration data permitted the plotting of curves for the various depths (Figure 1). In his testing of this type of instrument with chernozem-smolnitz soil A.

Vangelov (1) observed nonuniform desiccation in various parts of the calibration vessels. He found an appreciable difference in the moisture content of the soil sample in its different parts -- near the walls and bottom of the vessels and in the center where the transducers were mounted. This gave the author reason to doubt the usefulness of laboratory calibration for obtaining calibration curves. We used glass tanks, and covered the soil with cheese-cloth for slower and more uniform drying. Even so, as soon as moisture content fell below 10 percent (gravimetric), the soil retracted 1-2 millimeters from the walls of the vessels, whereby uniform drying was disturbed and measurements were halted.

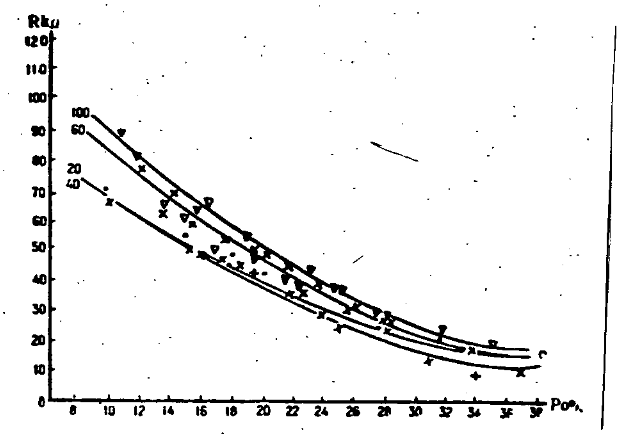

Figure 1. Relationship between soil moisture (P_{exp}) and electrical resistance (BKΩ) with laboratory calibration.

Key: $P_0 = P_{exp}$

In the field situation, transducers were set at eight depths in soil free of vegetation, the objective being to test the instrument's capabilities for measurement of moisture content at greater depths at the same time its suitability for our soil conditions was tested. In field calibration, the instrument was also compared with the gravimetric method, and samples were taken in the vicinity of the transducers with 10 repetitions. On conclusion of measurement by both methods the relationship between electrical resistance and soil moisture content was ascertained for each depth and for each transducer. The test data show that there is a good relationship in the range from wilting moisture up to maximum field moisture. Figure 2 shows this dependence for depths of 20, 40, 60 and 100 centimeters.

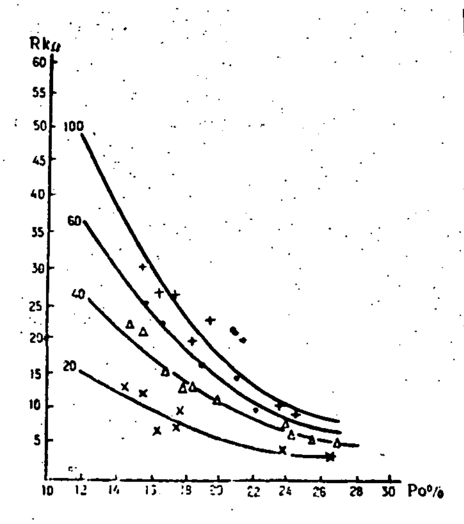

Figure 2. Relationship between soil moisture (P) and electrical resistance (BKΩ) with field calibration.

Key: $P_0 = P_{exp}$.

Fairly accurate data were obtained for the first three depths with both laboratory and field calibration, but below 100 centimeters deviation from the mean was very great, making the transducers unusable for greater depths. It should be noted that the following tendency is observed in the use of the resistance soil moisture meter, viz. the accuracy of soil moisture determination declines as the depth at which the transducers are set increases. Accuracy of the instrument is maximal up to 60 centimeters where discrepancies between measurement and graphic determination according to instrument data amount to three percent moisture content.

To verify the accuracy of the graphic relation between soil moisture content and electrical resistance of the soil a graph was plotted of the equality between experimentally determined moisture content P_{exp} and moisture content calculated from calibration curves P_{cal}. From the constructed graphs (Figure 3) -- verification of laboratory testing and verification of field testing -- it can be seen that the equalities are satisfied in both cases and the curves can be used for determination of soil moisture content by measurement of the electrical resistance of the soil.

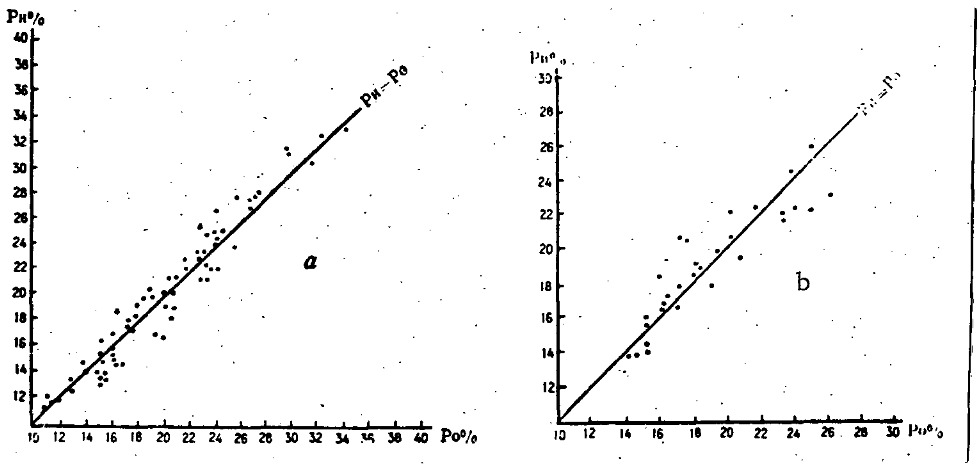

Figure 3. The equality $P_{cal} = P_{exp}$: a) during laboratory testing; b) during field testing.

Key: $P_0 = P_{exp}$; $P_И = P_{cal}$.

Our data corroborate the data known in the literature (1, 3, 4, 5), viz. that the accuracy of soil moisture determination by the AM-11 instrument is less than by the gravimetric method. Compared with the gravimetric method, this method gives great deviations which exceed the permissible limits of accuracy accepted in scientific research work. It can be used only for mass observations of soil moisture in forecasting the time for watering in irrigation systems and other cases.

BIBLIOGRAPHY

1. Vangelov, A., "Comparative Testing of AM-11 Meter in Measuring the Moisture Content of Chernozem-Smolnitz Soil," Khidrologiya i Meteorogiya (Hydrology and Meteorology), No 2, 1965.

2. Danilin, A. I., "Resistance Method of Measuring Soil Moisture by the Use of Carbon Electrodes in Glass Fiber," Trudy Nauchnoissledovatel'skogo Instituta Gidrometeorologicheskogo Priborostroyeniya (Works of the Scientific Research Institute of Hydrometeorological Instrument Manufacture), No 5, 1957.

3. Zmiyeva, Ye. S., and T. Markova, "Results of Soil Moisture Measurement by Resistance Soil Moisture Meter," Trudy TsIP (Works of the Central Institute of Weather Forecasts), No 99, Moscow, 1961.

4. Popov, L. V., Metody Opredeleniya Vlazhnosti Pochvy (Methods of Soil Moisture Determination), Moscow, Publishing House of the Academy of Sciences USSR, 1960.

5. Fedorov, S. F., "Results of Soil Moisture Observations by the IVP-53 Soil Moisture Meter," Trudy GGI (Works of the State Hydrological Institute), No 76, Leningrad, 1960.